WASTE FORM TESTING RESULTS FOR DOE AND COMMERCIAL POWER REACTOR WASTES

Steve Simpson
US Ecology, Inc.
Charlotte, NC

ABSTRACT

US Ecology, Inc. has developed a new asphalt for stabilization of low level radioactive waste and mixed waste. This asphalt, called High Strength Asphalt, retains the high leach resistance typical of other asphalts used in this application, and also provides a mechanical strength heretofore unachievable for asphalt waste forms.

This paper reports the available test data from the stability testing currently ongoing with this new asphalt.

INTRODUCTION

US Ecology, Inc. owns and operates a Transportable Volume Reduction System, called TVR III, which utilizes asphalt as the stabilization agent for low level radioactive waste. The system utilizes a thin-film evaporator, which evaporates the water from the waste and mixes the remaining solids with molten asphalt. This system is described in a Topical Report which was approved by the NRC in April, 1986 (1).

In addition, US Ecology is currently supplying two volume reduction systems utilizing asphalt to Virginia Power Company, for installation at the Surry and North Anna nuclear power stations.

The TVR III has been processing radioactive waste since August 1986 at the Palo Verde Nuclear Generating Station in Arizona and at the Clinton Power Station in Illinois. All waste processed to date has been Class A waste and has been solidified with AC-20 asphalt, a straight distilled asphalt used for road building, or with Type I roofing asphalt, an oxidized asphalt.

Although both of these asphalts provide excellent leach resistance, neither provides sufficient mechanical strength to yield the minimum 60 psi compressive strength required of Class B or C waste forms (2).

In 1987 US Ecology was awarded a contract by Commonwealth Edison Company to process approximately 11,000 gallons of a Class C chemical cleaning waste. This waste was generated in 1983 during

the cleaning of the Dresden Nuclear Generating Station's Unit 1 primary cooling system, using a proprietary chelating agent solvent known as NS-1, developed by Dow Chemical Company.

In preparation for the processing of this waste, US Ecology began testing of various asphalts in order to find an asphalt that would meet the Class B/C stability requirements (2), specifically the compressive strength requirement of 60 psi. This search resulted in the identification of an asphalt which US Ecology decided to dub High Strength Asphalt because of the unusually high mechanical strength it exhibited. Testing was initiated with this High Strength Asphalt, utilizing various simulated waste types, including NS-1, typical power plant wastes (resins, boric acid, sodium sulfate, diatomaceous earth, cellulose fiber, activated carbon) and two wastes which US Ecology was contracted to test for Martin Marietta (a metal plating sludge and a biodenitrification sludge, from the Oak Ridge National Laboratory reservation).

NS-1 TESTS

The NS-1 solvent is a proprietary formulation developed by Dow Chemical Company for the cleaning of nuclear reactor cooling and steam generating systems. The solvent contains chelating agents for the removal of radioactive scale from metal surfaces. IT Corporation holds the license for the use of this solvent.

In 1983, Commonwealth Edison Company contracted IT Corporation to clean Dresden Nuclear Generating Station's Unit 1 Primary Cooling System. The contract was successfully completed, leaving behind a large volume of contaminated NS-1 waste water. The waste was subsequently concentrated by evaporation resulting in approximately 11,000 gallons of concentrated NS-1 solvent.

The waste is classified as Class C, due to its concentration of long-lived transuranic isotopes and plutonium 241.

It was decided that, in order to ensure that no solidified product would be created which might exceed the Class C ceiling, a safety factor was incorporated into the volume reduction of the waste. It was determined that a volume reduction factor of 1.3 would create a product with an isotopic concentration of 75% of the Class C ceiling. A volume reduction factor of 1.3 corresponds to a stabilized product containing 40 weight percent solids and 60 weight percent High Strength Asphalt. Therefore, 40/60 was the solids to asphalt ratio used in making the specimens for stability testing.

Initial attempts to bituminize the waste were unsuccessful, due to the thermal decomposition of the waste and the resultant off-gassing of the molten bituminized product. A pretreatment was developed by SGN/CEA of France, US Ecology's licensors, which allowed successful bituminization.

Test specimens were prepared in a bench-scale evaporator/mixer, which evaporated the water from the simulated NS-1 waste while mixing the remaining solids with molten High Strength Asphalt. Specimens were also prepared by processing the simulated waste in a pilot-scale thin-film evaporator.

Testing was performed on the test specimens in accordance with the Technical Position on Waste Form (2). The test results are summarized in Table I.

As can be seen from the data in Table I, the NS-1/High Strength Asphalt waste form passed all of the stability tests specified in the Technical Position on Waste Form (2). The compressive strength of the waste form exceeded the required 60 psi by a wide margin. The stability data has been submitted to the NRC as a Topical Report (3) and is currently under review. Waste processing will begin when the Topical Report has been approved by the NRC.

MARTIN MARIETTA TESTS

US Ecology was contracted by Martin Marietta to prepare stabilized specimens from two mixed waste streams generated at the Oak Ridge National Laboratory - a biodenitrification sludge and a metal plating sludge. The stability test specimens were prepared with simulated waste.

The actual biodenitrification sludge contains approximately 40 to 45 wt.% solids, which are primarily calcium carbonate. Prior to biodenitrification, the liquid waste is high in nitrates at a concentration of 3 to 4 wt.%. Calcium acetate is added to the waste as a source of carbon for the denitrifying bacteria. The carbon is oxidized to carbonate while the nitrate is reduced to nitrogen gas. A large variety of metal salts at relatively low levels are present in the sludge as well as approximately 300 ppm phenolics and 1000 ppm uranium. Approximately 5% of the sludge mass comes from diatomaceous earth used in a filtration operation to concentrate the solids. The sludge and supernate contain primarily alpha emitters.

The actual metal plating sludge contains approximately 50 wt.% total solids, including 5% aluminum, 20% calcium, 4% phosphorus, and many metal hydroxides. Complex phenolics are present from the degradation and hydrolysis

TABLE I

NS-1 WASTE/HIGH STRENGTH ASPHALT

TEST	STANDARD	RESULTS
Compressive Strength	ASTM D1074	600-855 psi at 55°F
Leachability	ANS 16.1	
Demineralized Water		Co: 8.8 - 8.9 (Leach Index)
		Cs: 8.8 - 9.0
		Ni: 8.7 - 9.0
Sr: 9.4 - 9.5		
		Total Solids: 8.3 - 8.6
Seawater		Co: 9.6 - 9.8
		Cs: 8.7 - 9.2
		Ni: 9.3 -9.4
		Sr: 9.3 - 9.4
Compressive Strength After 90-Day Immersion	ASTM D1074	240-260 psi at 55°F
Compressive Strength After Irradiation to 10^8R	ASTM D1074	343 psi at 55°F
Biodegradation	ASTM G21	No Growth
	ASTM G22	No Growth
Compressive Strength after ASTM G22	ASTM D1074	*530-575 psi at 55°F*
Compressive Strength after ASTM G22	ASTM D1074	480-600 psi at 55°F
Compressive Strength after Thermal Cycling	ASTM D1074, ASTM B553	380-570 psi at 55°F

of hydraulic fluids, oils, and greases. The viscosity of the sludge is about 700,000 centipoise at 25 degrees C. The activity of the sludge is mostly from alpha emitters. The waste comes from metal plating operations, laboratory sink drains, metal preparation cleanup operations, decontamination processes and mop waters. The waste contains nitrate, cyanide, nickel, and cadmium. The waste is treated toprecipitate solids and centrifuged to 50 wt.% solids.

The bituminized specimens of both waste types were prepared in a bench-scale evaporator/mixer, which evaporated the water from the wastes and mixed the remaining solids with High Strength Asphalt at a mix ratio of 40 wt.% solids, 60 wt.% asphalt.

Because both of these wastes are mixed wastes, the test program included testing for EPA criteria and NRC criteria. US Ecology performed a portion of the stability tests, while Martin Marietta performed the balance of the tests on the bituminized specimens produced by US Ecology. At the time of submittal of this paper, the Martin Marietta test data were not yet available. The US Ecology test data are summarized in Table II and Table III.

As can be seen by the data in Tables II and III, both waste forms passed the stability tests conducted by US Ecology. The compressive strength exceeded the required 60 psi by a wide margin. The results of the tests performed by Martin Marietta, which include homogeneity, immersion, flash point, thermal gravimetric analysis, and leachability, will be published in March 1989.

TABLE II

BIODENITRIFICATION SLUDGE/HIGH STRENGTH ASPHALT

TEST	STANDARD	RESULTS
Compressive Strength	ASTM D1074	433-498 psi at 77°F
Compressive Strength After Irradiation to 10^8 R	ASTM D1074	245-668 psi at 77°F
Biodegradation	ASTM G21	No Growth
	ASTM G22	No Growth
Compressive Strength after ASTM G21	ASTM D1074	332-409 psi at 77°F
Compressive Strength after ASTM G22	ASTM D1074	398-501 psi at 77°F
RCRA Hazardous Characteristics	40 CFR 261	Non-Reactive Non-Ignitable Non-Corrosive

POWER PLANT WASTES

US Ecology is currently performing stability testing on waste forms formulated with High Strength Asphalt and typical power plant wastes, including bead resins, powdered resins, cellulosic filter aid, diatomaceous earth, activated carbon, boric acid concentrates and sodium sulfate concentrates. At the time of submittal of this paper, test results are not available, but results should be available for inclusion in the verbal presentation of the paper.

In addition to US Ecology's stability testing, pilot plant testing is underway at the CEA's Cadarache Nuclear Research Center in France. This testing involves the processing of each of these waste types in a pilot scale thin-film evaporator, using High Strength Asphalt, to determine optimum process parameters. The results of these tests will be available by the second quarter of 1989.

CONCLUSIONS

This new High Strength Asphalt shows great promise for the stabilization of radioactive and mixed wastes. Stability testing has shown that it exhibits excellent mechanical strength without sacrificing the high leach resistance for which asphalt has been noted.

REFERENCES

1. Topical Report, "ATI Transportable Volume Reduction and Bitumen Solidification System (TVR III), Report No. ATI-VR-002-P/NP-A, Associated Technologies, Inc. (October 1986).
2. "Technical Position on Waste Form," Rev. 0, US Nuclear Regulatory Commission (May 1983).
3. "Stability of NS-1 Solidified with High Strength Asphalt," Report No. USE-61-001-P, Revision 0, US Ecology, Inc. (July 15, 1988).

TABLE III

METAL PLATING SLUDGE/HIGH STRENGTH ASPHALT

TEST	STANDARD	RESULTS
Compressive Strength	ASTM D1074	390-406 psi at 77°F
Compressive Strength After Irradiation to 10^8 R	ASTM D1074	496-523 psi at 77°F
Biodegradation	ASTM G21	No Growth
	ASTM G22	No Growth
Compressive Strength after ASTM G21	ASTM D1074	337-360 psi at 77°F
Compressive Strength after ASTM G22	ASTM D1074	402-433 psi at 77°F
RCRA Hazardous Characteristics	40 CFR 261	Non-Reactive Non-Ignitable Non-Corrosive Non-EP Toxic